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4.2 GLOBAL CLIMATE MONITORING WITH THE EOS PM-PLATFORM'S ADVANCED MICROWAVE SCANNING RADIOMETER (AMSR-E)

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1.0 INTRODUCTION

The Advanced Microwave Scanning Radiometer (AMSR-E) is being built by NASDA to fly on NASA's PM Platform (now called "Aqua") in December 2000. This is in addition to a copy of AMSR that will be launched on Japan's ADEOS-II satellite in 2001. The AMSRs improve upon the window frequency radiometer heritage of the SSM/I and SMMR instruments. Major improvements over those instruments include channels spanning the 6.9 GHz to 89 GHz frequency range, and higher spatial resolution from a 1.6 m reflector (AMSR-E) and 2.0 m reflector (ADEOS-II AMSR). The ADEOS-II AMSR also will have 50.3 and 52.8 GHz channels, providing sensitivity to lower tropospheric temperature.

NASA funds an AMSR-E Science Team to provide algorithms for the routine production of a number of standard geophysical products. These products will be generated by the AMSR-E Science Investigator-led Processing System (SIPS) at the Global Hydrology Resource Center (GHRC) in Huntsville, Alabama. While there is a separate NASDA-sponsored activity to develop algorithms and produce products from AMSR, as well as a Joint (NASDA-NASA) AMSR Science Team activity, here I will review only the AMSR-E Team's algorithms and how they benefit from the new capabilities that AMSR-E will provide. The U.S. Team's products will be archived at the National Snow and Ice Data Center (NSIDC). Further information about AMSR-E can be obtained at http://www.ghcc.msfc.nasa.gov/AMSR.

2.0 AMSR-E INSTRUMENT CHARACTERISTICS

The AMSR-E is similar to the SSM/I in conceptual design, with an offset parabolic reflector and radiometer drum assembly rotating about a vertical axis, conically scanning across the Earth. From the 705 km altitude orbit of the PM Platform, the AMSR 47.4° view angle results in an Earth incidence angle of 55.0°, and its +/- 61° active scan angle provides a data swath width of 1445 km. Once during each scan a cold sky subreflector occults the feedhorn array's view of the Earth to provide a cold calibration measurements from the cosmic background. Similarly, a warm calibration target also occults the feedhorns to provide warm calibration measurements from a temperature-controlled high-emissivity target. Other characteristics of the AMSR sampling are contained in Table 1. Also listed are the spatial resolutions attained at each frequency from the 705 km orbital altitude of the PM Platform.

3.0 SPATIALLY RESAMPLED TB: THE "LEVEL 2A" DATASET

The AMSR instruments, owing to their very large range of channel frequencies, utilize an array of feedhorns, each located slightly off the focal point of the main antenna reflector. Most of the offset between feedhorns is in the cross-

Table 1. AMSR-E characteristics from the 705 km orbital altitude of the EOS PM Platform.

Center Frequencies (GHz)	6.925	10.65	18.7	23.8	36.5	89.0
Bandwidth (MHz)	350	100	200	400	1000	3000
Sensitivity (K)	0.3	0.6	0.6	0.6	0.6	1.1
IFOV (Km x km)	75x43	48x27	27x16	31x18	14x8	6x4
Sampling Interval (Km x km)	10x10	10x10	10x10	10x10	10x10	5x5
Integration Time (msec)	2.6	2.6	2.6	2.6	2.6	1.3
Main Beam Efficiency (%)	95.3	95.0	96.3	96.4	95.3	96.0
Beamwidth (half-power, degrees)	2.2	1.4	0.8	0.9	0.4	0.18

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track direction, which can then be adjusted for in the individual channels' integrate-and-dump timing. The 89 GHz channels, however, utilize two feedhorns, separated in the along-track direction. This accommodates their higher spatial resolution without having to double the instrument spin rate, but at the expense of measurements that are staggered along-track on either side of the other channels' measurements. These are small spatial offsets, however, in comparison with the very large range in spatial resolutions (IFOV= 6 km to 76 km) inherent in the diffraction-limited antenna system design.

These spatial mismatch issues led to our decision to develop a spatially resampled dataset for the retrieval of the standard geophysical parameters, and for other users of the Tb data. Frank Wentz and Peter Ashcroft, of Remote Sensing Systems, have responsibility for this activity. Fortunately, for most of the AMSR channels, there is a large amount of overlap between adjacent measurements at the same frequency, as can be seen in Table 1 from a comparison of the footprint sampling intervals to the IFOVs. The Backus-Gilbert approach described by Poe (1990) was implemented to resample the higher resolution channels to the lower resolution footprints. This technique results in a best fit of the low frequency channels beam patterns by a linear combination of the surrounding measurements from the higher frequency channels. This resampling/convolution is done separately for four channel sets: 6.9 GHz, 10.65 GHz, 18.7/23.8 GHz, and 36.5 GHz. Original footprint resolution Tb (Level 1B) data will be provided by NASDA.

4.0 GEOPHYSICAL PRODUCTS

The AMSR-E products follow the heritage of the SMMR and SSM/I instruments and their products. In many cases the algorithms are expected to provide improved products owing to more available channels, higher spatial reolution, or more stable calibration.

Table 2 summarizes the Level 2 (swath) products that will be routinely generated.

Table 2. Standard Level 2 (swath) products from AMSR-E.

PARAMETER	ACCURACY	SPATIAL RESOLUTION	INVESTIGATORS
Brightness Temperature (Tb)	$0.2^\circ - 0.7^\circ$ C	6 – 76 km	NASDA (Level 1B); F. Wentz (RSS, Level 2A)
Oceanic surface wind speed	0.9 m/s	12 km	F. Wentz (RSS)
Oceanic integrated water vapor	0.2 g/cm2	23 km	F. Wentz (RSS)
Oceanic cloud liquid water	3 mg/cm2	23 km	F. Wentz (RSS)
Sea Surface Temperature (SST)	0.5° C	76 km	F. Wentz (RSS)
Surface soil moisture	0.06 g/cm3 where vegetation is less than 1.5 kg/m2	25 km (equal area Earth grid)	E. Njoku (JPL)
Global Rainfall	Ocean: 1 mm/hr or 20%, whichever is greater Land: 2 mm/hr or 40%, whichever is greater	10 km	C. Kummerow (NASA/ GSFC) R. Ferraro (NOAA/NESDIS)
Rain Type (convection fraction)	N/A	10 km	C. Kummerow (NASA/ GSFC)

The newer capabilities in Table 2 are SST and surface soil moisture. The SST capability of passive microwave observations at 10.7 GHz has been recently demonstrated by F. Wentz with TRMM Microwave Imager (TMI) data. AMSR-E will allow SST retrievals to be done separately at 6.9 GHz and 10.65 GHz. The soil moisture retrievals build upon the SMMR experience, as well as several field experiments utilizing airborne microwave radiometers.

Level 3 (space- and/or time-averaged) products are listed in Table 3. Note the addition of sea ice parameters and snow cover parameters, which have no Level 2 counterparts. Also note the newer product, sea ice temperature, that is now possible with the 6.9 GHz channels of AMSR-E.

Validation of the standard products will involve a combination of aircraft measurements during field experiments, comparisons to other spaceborne microwave radiometer products (from SSM/I, TMI, SSM/IS, AVHRR), radar, in situ data from buoys, radiosondes, etc. These validation activities are being coordinated with NASDA though the Joint AMSR Science Team.

In addition to the standard products, several of the Team investigators will be producing and evaluating "research" products. These will not be archived by NSIDC, but could form the basis for future standard products later.

Table 3. Standard Level 3 (gridded) products from AMSR-E.

PARAMETER	ACCURACY	SPATIAL RESOLUTION	INVESTIGATORS
89 GHz Tb (daily, daily asc., daily desc.)		6.25 km	F. Wentz (RSS)
18.7, 23.8, 36.5, and 89 GHz Tb (daily, daily asc., daily desc.)		12.5 km	F. Wentz (RSS)
6.925, 18.7, 23.8, 36.5, and 89 GHz Tb (daily, daily asc., daily desc.)		25 km	F. Wentz (RSS)
Oceanic surface wind speed (daily, weekly, monthly)	0.9 m/s (daily)	0.25° grid	F. Wentz (RSS)
Oceanic integrated water vapor (daily, weekly, monthly)	0.2 g/cm2	0.25° grid	F. Wentz (RSS)
Oceanic cloud liquid water (daily, weekly, monthly)	3 mg/cm2	0.25° grid	F. Wentz (RSS)
Sea Surface Temperature (SST) (daily, weekly, monthly)	0.5 °C	0.25 ° grid	F. Wentz (RSS)
Surface soil moisture (daily)	0.06 g/cm3 where vegetation is less than 1.5 kg/m2	25 km (EASE grid)	E. Njoku (JPL)
Global Rainfall (monthly)	Ocean: 10% Land: 20%	5 ° grid	T. Wilheit (TAMU) R. Ferraro (NOAA/NESDIS)
Snow water equivalent (daily, 5-day, monthly)	10 mm or 20%	25 km (EASE grid)	A. Chang (NASA/ GSFC)
Sea Ice Concentration (daily, daily asc., daily desc.)	< 5%	6.25, 12.5, 25 km (EASE grid)	D. Cavalieri (NASA/GSFC) J. Comiso (NASA/GSFC)
Snow Depth over sea ice (5-day)	< 5 cm	12.5 km (EASE grid)	D. Cavalieri (NASA/GSFC) J. Comiso (NASA/GSFC)
Sea Ice Temperature (daily, daily asc., daily desc.)	< 4 °C	25 km (EASE grid)	D. Cavalieri (NASA/GSFC) J. Comiso (NASA/GSFC)

5.0 CONCLUSION

The AMSR-E (as well as the ADEOS-II AMSR) will provide passive microwave measurements of unprecedented quality for monitoring regional to global climate variability. With a wide range of frequencies (6.9 GHz though 89 GHz), and a relatively large (1.6 m) main reflector, AMSR-E will allow further improvements in our ability to monitor and understand variations in the Earth system.

6.0 REFERENCES

Poe, G.A., 1990: Optimum interpolation of imaging microwave radiometer data. *IEEE Trans. Geosci. Rem. Sens.*, **28**, 800-810.